Department of Health and Social Security

Report on Health and Social Subjects
17

FOODS WHICH SIMULATE MEAT

The nutritional aspects of vegetable protein foods which are meat analogues

Report of the Panel on Novel Foods
Committee on Medical Aspects of Food Policy

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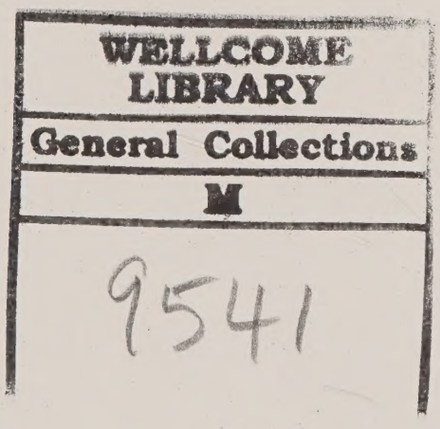

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Preface

Vegetable foods, like most foods, provide a mixture of nutrients and some, for example peas, beans and lentils, are better than others as sources of plant protein in the diet. However, most people in the United Kingdom rely chiefly on animal sources of dietary protein such as milk, meat, fish, eggs and cheese. Although it is now recognised that, if the energy needs of an individual are satisfied by a suitable mixture of foods, the need for protein is also met, nutritionists in the past have placed considerable emphasis on possible shortages of dietary protein. Comparatively recently the food industry perfected methods for isolating protein from vegetable sources and then made this into a new food which has the texture of, and looks, smells and tastes like meat.

In 1974, the Food Standards Committee published a report entitled 'Novel Protein Foods' and the Committee on Medical Aspects of Food Policy (COMA) supplied an appendix on the nutritional aspects of these foods. COMA enunciated the principle that any manufactured food which simulated a natural food should in all important respects have the same nutritional value as the natural food which it simulates. The decision as to which nutrients are to be considered as important in the food may change with advancing knowledge. Thus, from time to time advice to manufacturers about the nutrient composition of vegetable protein foods which are made to resemble meat may need to be reconsidered.

In response to advances in knowledge, the Committee on Medical Aspects of Food Policy, in 1978, set up a Panel of Experts under the Chairmanship of Dr E. M. Widdowson CBE FRS to review the nutritional recommendations made in the 1974 Food Standards Committee Report.

This present report contains the findings of the Panel and their new recommendations for the nutrient composition of vegetable protein foods which simulate meat. New foods which simulate natural foods such as meat may well replace the natural food in the diet to a greater or lesser extent and it is a matter of concern for public health that the replacement has no deleterious effect on the nutrient content of the diet as a whole. The thanks of the Department are due to Dr Widdowson and members of the Panel on Novel Foods as well as to the Committee on Medical Aspects of Food Policy for giving their time and expert knowledge in this matter.

H. YELLOWLEES,
Chairman,
Committee on Medical Aspects of Food Policy

October, 1979

1. Introduction

1.1 Background information

In 1973 the Committee on Medical Aspects of Food Policy set up a Working Party under the Chairmanship of Dr E. M. Widdowson at the request of the Food Standards Committee to advise about which nutrients, if any, should be included compulsorily in textured vegetable protein foods that might be used to replace meat, and to state the minimum amount of those nutrients. The Working Party took note of the principle enunciated in 1972 by the Committee on Medical Aspects of Food Policy that "any substance promoted as a replacement or alternative to a natural food should be the nutritional equivalent in all but unimportant aspects of the natural food which it would simulate". The findings of the Working Party were published in the Food Standards Committee Report on Novel Protein Foods (Ministry of Agriculture, Fisheries and Food, 1974; Appendix 2). One of the recommendations was that the nutrient content of textured vegetable protein foods which simulate meat and of other foods which may be developed in the future should be kept under review.

1.2 Terms of Reference

In order to undertake this review of the 1974 recommendations the present Panel on Novel Foods was set up in 1978 under the Chairmanship of Dr E. M. Widdowson by the Committee on Medical Aspects of Food Policy. The terms of reference of the new Panel were twofold:

1. To review the recommendations made in 1974 by the Working Party on Novel Protein Foods concerning textured vegetable protein foods which simulate meat.

2. To consider the nutritional aspects of any novel food or novel food process submitted by manufacturers under scrutiny arrangements to be set up by the Ministry of Agriculture, Fisheries and Food.

This report is concerned with the first of the two terms of reference.

1.3 Acknowledgements

The members of the Panel gratefully acknowledge the helpful information given by the members of the Vegetable Protein Section of the Food Manufacturers' Federation Incorporated, London, and the Nutrition and Technical Services Division of the United States Department of Agriculture, Washington, D.C.

2. General Considerations

2.1 Food technology now enables manufacturers to produce foods which simulate natural animal protein foods such as meat, fish and cheese, from novel vegetable protein materials or by means of novel processes. Vegetable protein products, whether textured or not, are being used to replace meat or to increase the "meat" content of a product and are generally available at competitive prices. The previous recommendations made by the Working Party on Novel Foods (para 3.1; 1974 Report) were intended to apply to these products whether derived from the soya bean, or the field bean or other plants. The field bean is not now used and products at present available and which simulate meat are mainly derived from soya bean protein.

2.2 There was some concern that the recommendations made in 1974 may have been thought to apply to products which simulated any food rich in protein, for example cheese or fish. This was not the intention of the 1973–74 Working Party. Similarly the considerations outlined in this report are only applicable to textured vegetable protein products which simulate meat.

2.3 The Working Party considered that a substitute food should not simulate a natural food in chemical composition (ie nutrient content) only, but that other factors such as the biological availability of nutrients should be taken into account. Textured vegetable protein products which simulate natural foods other than meat, such as cheese, should be considered separately because of the different nutritional properties of these natural foods. Ideally, each new food requires an individual nutritional assessment. In these circumstances it would be impossible to provide recommendations on nutrient composition which could be applied to all new products. New products are covered by arrangements to be set up by the Ministry of Agriculture, Fisheries and Food.

2.4 Although most people in the United Kingdom have an adequate diet, some members of large families with a low income and some elderly persons, particularly those suffering from chronic illness, may be at risk of relatively poor nutrient intakes. Unless substitute foods are nutritionally equivalent to the natural foods which they displace in the diet, widespread consumption of these foods could have unforeseen adverse effects on health. Diets could become deficient in some essential nutrients such as particular amino acids, vitamins, minerals or essential fatty acids. Theoretically, it is possible to overcome some of these problems by appropriate fortification, but in many instances there is insufficient scientific knowledge on which to base sound recommendations.

2.5 In institutions, schools, hospitals, prisons or the Services, some degree of control over the use of substitute foods may be prudent in order to limit, at least for the time being, the extent to which these foods are allowed to displace natural foods.

2.6 Individuals who buy their own food are free to alter the composition of their diet as they wish. Furthermore, vegetable protein foods could be mar-

keted as foods in their own right without the pretence of substituting for other natural foods, and any recommendations pertaining to these foods would then need to be based on different criteria. Great importance should be attached to the labelling of products, to the information which is provided by the manufacturers, and to nutrition education, so that the public may make a wise and informed choice.

3. Textured Vegetable Protein Foods which Simulate Meat

3.1 In the United Kingdom meat is an important source of protein in the diet (Table 1). Any food which simulates and is to be used as a substitute for meat should therefore provide similar amounts of protein of comparable quality and biological availability. Meat is also an important source of other nutrients such as riboflavin, vitamin B_{12} and the minerals iron and zinc (Table 1). However, some groups of people who eat meat or meat products may well have diets of relatively poor quality (para 2.4) and, were they to substitute vegetable foods which simulate meat for all meat, they could be at risk of some deficiency of nutrients supplied by natural meat not present in sufficient quantity in the vegetable food. Nevertheless vegetarian diets are generally of good quality and vegetarians in the United Kingdom show little haematological evidence of nutrient deficiencies (Sanders, Ellis and Dickerson, 1978).

3.2 The 1974 Working Party considered these problems and put forward recommendations for the nutrient content of textured vegetable protein foods which simulate meat. In the light of further experience and new scientific evidence it is now necessary to review those recommendations. However, scientific knowledge in this field is still far from adequate, and further reviews of recommendations are therefore envisaged in the future.

Table 1: Contribution of meat to the average daily 'consumption' (based on National Food Survey information) of some nutrients[1] in the United Kingdom in recent years

Nutrient		Average total daily intake from whole diet	Contribution from meat Average daily intake	Contribution from meat % of total intake
Energy	kcal	2261	366	16
	MJ	9.5	1.52	
Protein	g	72.3	22.5	31
Iron	mg	11.0	2.6	24
Zinc	mg	9.1	3.3	36
Copper	mg	1.51	0.43	28
Thiamin	mg	1.23	0.17	14
Riboflavin	mg	1.81	0.36	20
Nicotinic acid equivalent	mg	29.1	10.2	35
Pyridoxine	mg	1.36	0.31	23
Vitamin B_{12}	μg	6.6	3.9	59
Retinol equivalent	μg	1474	547	37

[1] Meat is also a significant source of phosphorus and selenium but provides less than ten per cent of the average daily intake of calcium, magnesium, manganese, folic acid, ascorbic acid and vitamin D.

Source: Ministry of Agriculture, Fisheries and Food, 1978.
Spring, Robertson and Buss, 1979.

4. Water Content

The 1974 Working Party recommended that the moisture content of hydrated textured vegetable protein products should be not less than 60 and not more than 65 per cent. The recommendation was based on the known moisture content of fresh meat, but manufacturers have found it technically difficult to control the moisture content of hydrated products to within these narrow limits. Furthermore, manufacturers already market dry products and there can be little if any control over what individuals do with the product. The Panel therefore decided that no recommendations should be made concerning the water content of the product.

5. Protein and Amino Acids

5.1 Protein content

Protein content is usually calculated as 6·25 × total nitrogen. After due consideration of the variation in the protein content of different meats, the 1974 Working Party chose, as a standard, good quality raw stewing steak, that is to say, meat with a relatively high muscle protein and a moderate fat content, and recommended that textured vegetable protein products which simulate meat should contain not less than 50 per cent protein on a dry weight basis. Although this recommendation could easily be met by manufacturers of highly refined protein isolates, it has caused problems for manufacturers of the less refined extruded products. In addition, much meat consumed in the United Kingdom has a lower protein content and a higher fat content than the reference stewing steak. For these reasons the Panel recommends that the protein content of textured vegetable protein foods which simulate meat shall be not less than 45 per cent, but preferably 50 per cent, of the dry weight of the product.

5.2 Protein quality

5.2.1 Because of the lower methionine content of soya protein and, in particular, because of the lower methionine and cyst(e)ine content of field bean protein compared with the amounts of these amino acids present in beef protein, and because methionine was regarded as the limiting amino acid present in these vegetable proteins, the 1974 Working Party recommended that textured vegetable protein products which simulate meat should have a minimum methionine content. For a number of reasons this recommendation now needs to be reviewed: (a) objections have been raised against the use of the methionine content of good quality raw stewing steak as a standard with which to compare the quality of textured vegetable proteins. Protein quality depends on the type of meat used, and the quality of the protein may be altered by processing, especially in the presence of other food ingredients, as for instance in the preparation of canned dishes containing meat, vegetable and gravy (Bender and Husaini, 1976). In practice the biological value of meat protein consumed may be less than the theoretical values obtained for the raw material. (b) The field bean is no longer used as a source of textured vegetable protein in the United Kingdom and most products are now based on soya protein which has a higher cyst(e)ine content than good quality beef. To some extent cyst(e)ine has a "sparing" effect on the requirement for methionine. (c) The addition of free methionine caused technical difficulties for some manufacturers and was associated with flavour problems. A decision had to be taken therefore as to whether or not the addition of methionine to soya based textured vegetable protein foods would confer any nutritional advantage to the consumer and whether alternative criteria should be used to assess the protein quality of these products.

5.2.2 Much of the available information about the amino acid composition of food cannot be used for the purposes of comparison because of differences in

analytical technique, problems in the interpretation of results and differences in the quality of the foods analysed. The chemical composition of a textured vegetable protein gives a guide to its potential value, but in practice several factors may prevent such a potential from being achieved (Synge, 1976). Protein quality may be considerably altered by physical or chemical processing. For instance, treatment with alkali, in the preparation of some protein isolates, may cause racemisation of amino acids or chemical reactions involving amino acid residues such as methionine or lysine. Such processes may reduce the biological value of the protein. Some substances produced during processing may have toxic or antinutritional effects, interfere with the absorption of other nutrients or increase energy requirements due to increased activity of detoxification mechanisms. However, suitable heat treatment can improve the nutritional quality of legume-seed protein, probably due to an effect on the trypsin-inhibitor and lectin proteins. Excessive heating can damage the protein and reduce its biological value (for instance, lysine side chains may be involved in cross-linking reactions). Even the process of extrusion may be associated with a change in protein quality. In some instances it is not known why a discrepancy occurs between the chemical score and the biological value of a protein; more research in this area is required.

5.2.3 Biological tests have indicated that sulphur amino acids are limiting in soya protein. However, the reduction in available lysine which can occur when legume-seed proteins are processed or cooked suggests that lysine could also be a limiting amino acid in these foods as served.

5.2.4 The average United Kingdom diet contains a mixture of proteins from three types of food which are milk and milk products, meat and cereals. Although specific amino acids may be limiting when a small amount of a particular protein is consumed as the sole source of protein in the diet, this finding has little relevance to the overall quality of protein in a mixed diet. Methionine and cyst(e)ine are fairly evenly distributed between the chief foods which provide protein in the United Kingdom diet. Lysine is not distributed so evenly among protein foods; cereal products provide a small proportion and meat a greater proportion of the daily intake of this amino acid. Substitution of meat by soya protein products would be unlikely to lead to any deficiency of lysine in the average United Kingdom diet. However, the fact that lysine is the amino acid most susceptible to cooking damage must be borne in mind.

5.2.5 In any diet the quality of the protein (and so any problem of a limiting amino acid) is of importance only when the protein intake is marginal. Most people in the United Kingdom consume far more than their physiological needs, but particular individuals such as some elderly people or those who suffer some chronic illness could have marginal or even deficient protein intakes. In such circumstances an increase in total protein intake would be a more appropriate remedy for their undernutrition than an attempt to alter the amino acid composition of particular foods. In special circumstances, such as in the treatment of some forms of renal failure with low protein diets or in the treatment of some inborn errors of metabolism, it may be necessary to consider the amino acid composition of the diet in greater detail. Such special problems should not prevent the formulation of recommendations related in more general terms to the nutritional needs of the majority of the population.

5.2.6 The problems outlined above indicate that the assessment of protein quality should be based on a biological test rather than a chemical analysis of the amino acid content of the protein. However, the limitations of such methods must be recognised. Little is known about the overall quality of protein in different types of diet consumed in the United Kingdom. Nevertheless, biological tests can provide evidence of poor biological availability, whether due to a 'limiting' amino acid or the presence of an unknown antinutritional factor. Furthermore, if such tests are performed on the product to be sold, any serious deleterious effects of factory processing on protein quality should be revealed. The Panel accepts that processing will almost inevitably cause some change in the quality of textured vegetable protein.

5.2.7 The Panel recommends that the quality of the product, as sold, should be assessed using a test of biological availability. Textured vegetable protein foods which simulate meat should have a Protein Efficiency Ratio (PER) of not less than 1.6 (65 per cent of PER for casein), or a Net Protein Utilisation (NPU) value of not less than 60. Meat is an unsuitable reference material because of the variability in quality and casein should be used as the standard of protein quality. A test of protein quality would only need to be made once provided the source of the vegetable protein and the processes involved remained the same thereafter. The use of different plant materials or a change in the manufacturing process would require further biological tests of the protein quality of the product. Any additional means of monitoring the quality of the product, after the initial test of protein quality, should be left to the discretion of the manufacturers. Should a product not meet the required standard of protein quality the onus would be on the manufacturer to investigate the matter further and if necessary to supplement the product appropriately to achieve the required protein quality.

6. Fat

6.1 The 1974 Working Party suggested that textured vegetable protein foods which simulate meat should contain no more fat than that present in raw lean beef stewing steak. In the case of extruded products the requirements for a minimum protein content and the presence of dietary fibre would limit the proportion of fat which could be present. The fat content of textured vegetable protein foods is unlikely to exceed substantially that present in raw lean stewing steak and is also unlikely to exceed that present in the other cuts of meat which commonly contribute to the average United Kingdom diet. Accordingly, the Panel preferred not to make any specific recommendations about the fat content of textured vegetable protein foods.

7. Vitamins

7.1 Because meat is a valuable source of thiamin, riboflavin and vitamin B_{12} (Table 1), the 1974 Working Party recommended that not less than a minimum amount of these vitamins should be present in textured vegetable protein products which simulate meat. These amounts were stated in terms of the dry weight of the product which was assumed to contain about 50 per cent protein. However, the amounts of water soluble vitamins and minerals would be approximately proportional to the protein content of meat. The 1974 recommendations had not taken into account the possibility that some products such as textured vegetable protein isolates could have protein contents far in excess of that of meat. Since less of a product with a high protein content would be needed to replace a particular quantity of meat on a protein equivalent basis, the Panel considered that vitamins and minerals (p.11) should be expressed in terms of protein content rather than in terms of the dry weight of the product.

7.2 Previous recommendations were that textured vegetable protein foods should contain 2 mg thiamin per 100 g dry matter which, on the assumption that the dry product is 50 per cent protein, is equivalent to 4 mg thiamin per 100 g protein. This figure is the thiamin content, on average, of raw pork meat. Other meats (beef, lamb, veal, chicken) have a much smaller thiamin content with a range 0.3–0.7 mg thiamin per 100 g protein. Luncheon meat, pork sausages and beef sausages also have a thiamin content within this range. The Panel was of the opinion that the recommendation about thiamin content had been set too high by the previous Working Party and agreed that this should be reduced to 2.0 mg thiamin per 100 g protein. The Panel found no reason for changing the previous recommendations concerning the riboflavin and vitamin B_{12} content of vegetable protein foods which simulate meat. If these recommendations are expressed in terms of protein instead of dry weight, vegetable protein foods which simulate meat should contain not less than 1.6 mg riboflavin and 10 μg vitamin B_{12} per 100 g protein. The Panel also found no reasons for any alteration of the view expressed by the previous Working Party about the other vitamins (1974 Report paras 4.7.1, 4.7.2.1 and 4.7.2.2).

8. Minerals

8.1 Introduction

8.1.1 The 1974 Working Party made specific recommendations only for the amount of iron which should be present in textured vegetable protein foods that simulate meat. There was at that time insufficient knowledge upon which to base recommendations for any other minerals. Even now little is known about the normal daily requirements of many inorganic nutrients and still less about the biological availability of these nutrients in the diet of man. However, members of the Panel thought that there was sufficient evidence available to reconsider the recommendations for the iron content of textured vegetable protein foods which simulate meat and also that the zinc content should now be considered. Table 1 indicates that meat contributes approximately one-quarter of the iron and more than one-third of the zinc in the United Kingdom diet.

8.2 Iron

8.2.1 The FAO/WHO (1970) expert committee which reviewed the evidence concerning the availability of iron in foods suggested that the available iron in soya bean products may be as high as 20 per cent of the total compared with an upper limit of 10 per cent for other plant foods (cereals, vegetables and pulses) and about 30 per cent for meat. The results do not necessarily apply to the iron in the textured vegetable protein foods after processing.

8.2.2 In the light of the above facts and after consideration of the iron content, on average, of beef stewing steak, the 1974 Working Party recommended that textured vegetable protein foods which simulate meat should contain a minimum of 10 mg of iron per 100 g of dry material, (20 mg iron per 100 g protein, if the dry food is 50 per cent protein). Recent evidence has suggested that these recommendations should be reconsidered.

8.2.3 The following facts concerning iron absorption in man must be borne in mind:

(a) haem iron is better absorbed than non-haem iron,
(b) meat enhances the absorption of non-haem iron in the diet and
(c) phytic acid reduces the availability of non-haem iron.

Studies with human subjects have indicated that approximately one-third of the haem iron in the diet is absorbed compared with only 5–6 per cent of non-haem iron (Layrisse and Martinez–Torres, 1972; Björn-Rasmussen, Hallberg, Isaksson and Arvidsson, 1974). Cook (1977) has also shown that a reduction in the meat content of the diet causes a reduction in the absorption of non-haem iron. Calculations based on the assumption that up to 30 per cent of meat in the diet might be replaced by textured vegetable protein foods (para 9.3) indicate that the iron content of these foods recommended by the 1974 Working Party might be too small. The decreased intake of haem iron and of unidentified "meat factors" which are present in meat, poultry and fish and which enhance the absorption of non-haem iron, could reduce the availability of iron. In the light of a recent review by Monsen, Hallberg, Layrisse, Hegsted,

Cook and Finch (1978) on the effects of the composition of the diet on the availability of iron, the Panel considers that the iron content of textured vegetable protein foods which had been recommended by the 1974 Working Party could well have been too small and that the iron content of these foods should perhaps be as much as 40 mg iron per 100 g protein.

8.2.4 However, although there is no evidence to suggest that the above arguments are invalid, the Panel recognises that no information is available about the utilisation of iron from textured vegetable protein products in man. The Panel strongly recommends that such research be initiated. Studies of the technical aspects of increasing the iron content of textured vegetable protein foods should also be made so that should any need to add iron salts to these products be revealed, and recommendations to this effect be made in the future, there would be no delay in implementing such recommendations.

8.2.5 Members of the Panel finally decided that the iron content of vegetable protein foods should be reviewed in about two years from the publication of this report by which time additional evidence from the research recommended above (para 8.2.4) should be available. In the meantime, the Panel confirms the recommendation of the 1974 Working Party that textured vegetable protein products which simulate meat should contain a minimum of 20 mg iron per 100 g protein. When the iron content in any textured vegetable protein food which simulates meat is below this minimum, ferrous sulphate, or any other non-toxic iron salt which is known to be absorbed by man, should be added.

8.3 Zinc

8.3.1. Meat is an important source of available zinc in the diet and evidence from studies with rats indicates that the zinc present in textured vegetable protein foods is poorly absorbed. Qualitative information shows that in some animals and in man the utilisation of dietary zinc is inversely related to the amount of phytic acid in the diet (Reinhold, Faradji, Abadi and Ismail-Beigi, 1976a,b). Quantitative information is not available for man. Dietary fibre may also affect the utilisation of zinc adversely.

8.3.2 Ideally, calculations of the minimum zinc content of textured vegetable protein foods that stimulate meat should be based on the following information:

(a) the decrease in the amount of zinc in the diet were meat to be replaced by these foods,
(b) the effect of such a substitution on the phytate/zinc ratio of the total diet, and
(c) the influence of the resulting change in phytate/zinc ratio on the absorbability of dietary zinc.

Sufficient information does not yet exist, particularly for (c), to permit such calculations.

8.3.3 An appraisal of the possibly desirable content of zinc in textured vegetable protein foods was therefore based on a consideration of the following:

(a) the effects of dietary phytate on zinc absorption in rats (Davies and Nightingale, 1975; Davies and Olpin, 1979)
(b) the effects on rat growth of changing the phytate/zinc ratio by zinc supplementation of diets containing textured vegetable protein food, and
(c) the known phytate and zinc contents of some currently available textured vegetable protein products.

8.3.4 Experiments with rats show that when the ratio, by weight, of phytate to zinc in a diet exceeds about 100, adverse biological effects arise which are abolished if the diet is supplemented with zinc salts. Nineteen samples of textured vegetable protein foods analysed at the Rowett Research Institute, Aberdeen, had a mean content of phytate of 1630 mg/100 g dry product and a phytate/zinc ratio of 375 (Davies and Reid, 1979). If it is assumed that phytate/zinc ratios exceeding 100 have a similar adverse effect upon the availability of dietary zinc to man, adjustment of the phytate/zinc ratio of textured vegetable protein to, say 80, would necessitate fortification of textured vegetable protein food to give a zinc content of approximately 20 mg/100 g dry product or, assuming a 50 per cent protein content, 40 mg zinc/100 g protein. These calculations take no account of the amounts of phytate and zinc in the rest of the diet. Such information is not yet available for the typical United Kingdom diet and should be obtained. In the light of such uncertainties the Panel recommends that investigations should be initiated to determine whether the high phytate/zinc ratio of vegetable protein products which simulate meat has an effect on the utilisation of dietary zinc by man similar to that found in rats.

8.3.5 On current evidence from animal studies the Panel recommends a minimal content of 20 mg zinc/100 g protein in textured vegetable protein foods which simulate meat. Although the recommendation disregards the possible effect of phytate on zinc absorption, this amount will at least ensure that the partial substitution of meat by textured vegetable proteins will not decrease the total intake of zinc. The recommendation will be reviewed when sufficient evidence becomes available to determine whether or not the phytate content of textured vegetable protein influences the absorption of dietary zinc by man.

8.3.6 Where supplementation is necessary, zinc sulphate, zinc carbonate or any other non-toxic zinc salt which is known to be absorbed by man should be added during the manufacturing process.

9. Consideration of the use of Textured Vegetable Protein Foods in Institutional Catering

9.1 The problems which could theoretically be associated with the replacement of natural meat in the diet by textured vegetable protein foods have been discussed in paragraphs 2.4, 2.5 and 2.6. Comparatively little was known in the early 1970s of the nutritional effects of inclusion of textured vegetable protein foods in the diet. The previous Working Party was therefore cautious and suggested that the proportion of hydrated vegetable protein food which simulates meat should not exceed 10 parts by weight per 90 parts of natural meat in any meal, or, for convenience in institutional catering, in a menu cycle. The present Panel considers that some restriction on the use of textured vegetable protein products as meat substitutes continues to be necessary, particularly in establishments which cater for groups of people who have little personal control over the quality of their diet (for example, members of the armed forces and people in long-stay hospitals and homes).

9.2 For more than 7 years the United States Department of Agriculture has permitted up to 30 per cent of meat to be replaced by suitably fortified textured vegetable protein food in its school lunch programme and no evidence has been forthcoming of any harmful effects resulting from this substitution. The considerations outlined in section 5 indicate that a substantial replacement of meat protein by soya protein would not seriously affect the methionine or lysine content or the protein quality of the average United kingdom diet, particularly when measures are taken to ensure that the vegetable protein is of good quality. However, for persons with marginal intakes of protein the effects of replacing meat in their diet with textured vegetable protein foods merits special consideration. That the high phytate content and possibly high dietary fibre content of some products may adversely affect trace metal absorption has already been discussed.

9.3 Textured vegetable protein products may vary considerably in composition and the extent of the replacement of meat by textured vegetable protein should be described in terms of parts by weight of protein rather than hydrated product (see Appendix). The Panel recommends that, in any meal, or in the case of institutional catering, in a menu cycle, the proportion of dietary protein from textured vegetable foods which simulate meat should not exceed 30 parts by weight per 70 parts of natural meat protein. No hard or fast rules are envisaged as to how the 30 per cent substitution of meat protein is achieved in catering. Those responsible for planning the diets of certain groups of people, particularly the elderly, will need to bear in mind that the introduction of vegetable protein foods may affect palatability and can be associated with excessive flatulence.

10. Use of Non-Textured Vegetable Protein Foods

10.1 The criteria and recommendations set out in this report should also be applied to non-textured vegetable protein preparations (eg powders) when these are incorporated into meat products in such a way as to replace the meat.

11. Recommendations

11.1 Vegetable protein foods which simulate meat shall contain, on a dry weight basis, not less than 45 per cent and preferably 50 per cent protein. Protein is defined as 6.25 × total nitrogen.

11.2 The protein quality of a vegetable protein product, as sold, shall first be assessed using a biological test. Textured vegetable protein foods which simulate meat should have either a Protein efficiency Ratio (PER) of not less than 1.6 or have a Net Protein Utilisation value (NPU) of not less than 60. Casein (PER value of 2.5) should be used as a standard of protein quality. A change in the type of plant material used or a change in the manufacturing process would require a further assessment of the protein quality of the product using a biological test.

11.3 Textured vegetable protein products which simulate meat shall contain per 100 g of protein not less than:

2.0 mg thiamin
1.6 mg riboflavin
10 μg vitamin B_{12}

11.4 Vegetable protein products which simulate meat shall contain a minimum of 20 mg iron per 100 g protein. When the iron content of any textured vegetable protein food which simulates meat is below this minimum, ferrous sulphate or any other non-toxic iron salt which is known to be absorbed by man should be added.

11.5 Vegetable protein products which simulate meat shall contain not less than 20 mg zinc per 100 g protein. When the zinc content of any textured vegetable protein food which simulates meat is below this minimum, zinc sulphate or carbonate or any other non-toxic zinc salt which is known to be absorbed by man should be added.

11.6 The Panel recommends that in institutional catering the proportion of vegetable protein which may replace meat protein in the diet should not exceed 30 parts by weight (of protein) per 70 parts of natural meat protein.[1]

11.7 The Panel reaffirms the views of the 1974 Working Party on Novel Protein foods that:

(a) the nutrient content of these foods and of others which may be developed in the future should be kept under review;
(b) the amounts of these foods which replace meat in institutional catering should be kept under review;
(c) further research is needed into the nutritional value of these foods (para 8.2.4 and 8.3.4), and into the assessment of any long-term effects of their inclusion in the diet of the United Kingdom.

[1] Caterers, please see Appendix.

11.8 The Panel advises that these recommendations be reviewed from time to time in the light of new scientific evidence.

11.9 The Panel recommends that any product simulating a natural food other than meat shall receive special consideration with regard to usage, nutrient composition and fortification.

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Appendix

Guidelines for Caterers

1.1 To one pound of dry vegetable protein product which simulates meat, 2 lb (1 pint 12 oz) water or stock should be added. If used with 6 lb natural meat, in the resulting 9 lb of "mixture" 30% of the meat protein has been replaced by vegetable protein as recommended in this report.

1.2 Explanation:

(a) Natural meat is about 20% protein. Hence 6 lb (2726g) natural meat contains about 545g protein.

(b) Dry vegetable protein products which simulate meat contain 50% protein, and therefore one pound (454g) of dry vegetable protein product which simulates meat contains 227g protein.

(c) The 9 lb mixed meat and hydrated vegetable protein product contains 545 + 227= 772g protein. Of this 227g comes from vegetable protein which is approximately 30% of the total.

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